Citation:

Davis JN, Alexander KE, Ventura EE, Toledo-Corral CM, Goran MI. Inverse relation between dietary fiber intake and visceral adiposity in overweight Latino youth. *Am J Clin Nutr.* 2009; 90: 1,160-1,166.

PubMed ID: 19793854

Study Design:

Cross-Sectional Study

Class:

D - Click here for explanation of classification scheme.

Research Design and Implementation Rating:

POSITIVE: See Research Design and Implementation Criteria Checklist below.

Research Purpose:

- To examine relationship between longitudinal changes in dietary variable over one to two years with changes in adiposity variables and glucose and insulin indexes in overweight Latino youth
- Hypothesis: Reductions in sugar intake and increases in dietary fiber are related to reductions in obesity and related metabolic disorders.

Inclusion Criteria:

Participants in Study of Latino Adolescents at Risk for Diabetes (SOLAR) cohort study who met following criteria:

- Two complete annual visits (48.2% having one year between visits and 51.8% with two years between visits) with data on dietary intake, adiposity measures and glucose and insulin indexes
- Eight to 13 years old
- BMI at 85th or higher percentile for age and sex based on CDCP guidelines
- Latino ancestry (all four grandparents of Latino origin as determined by parental self-report)
- Family history of type 2 diabetes in one or more parent, sibling or grandparent determined by parental self-report.

Exclusion Criteria:

- Could not be taking medicines known to affect body composition, have syndromes or diseases known to affect body composition or fat distribution or have had any major illness since birth

- Had to be plausible (i.e., excluded if reported being sick or having braces tightened at time of dietary data collection, or if outside plausible caloric intake (two SDs or more than residual from the mean).

Description of Study Protocol:

Recruitment

- Participants already enrolled in SOLAR study
- Recruitment method not described
- 100% Latino youth.

Design

- Cross-sectional longitudinal observational study
- Overweight Latino youth were measured on the following over two years (±SD time difference of 1.5±0.5 years):
    - Dietary intake by two-day diet recalls, body composition by dual-energy X-ray absorptiometry (DEXA) and magnetic resonance imaging and glucose and insulin indexes by oral- and intravenous glucose tolerance tests
    - Partial correlations and repeated-measure analysis of covariance assessed relationship between changes in dietary intake with changes in adiposity and glucose and insulin indexes, independent of following a priori covariates:
        - Sex
        - Tanner stage
        - Time between visits
        - Baseline dietary and metabolic variables of interest.

Dietary Intake/Dietary Assessment Methodology

- Two 24-hour diet recalls (two weekdays) were collected at each annual visit using the multiple pass technique (first done in person with skilled bilingual dietary technician using three-dimensional food models; second done by the same technician by phone one week after the first)
- Analyzed average of two diet recalls per year (or, in some cases average of two diet recalls over two years) with NDS-R software program. Calculated total sugars, dietary fiber, added sugar, glycemic index and glycemic load (using both standard glucose and white bread reference). Also calculated servings of food and beverage group based on 2005 Dietary Guidelines for Americans or the FDA.

Statistical Analysis

- In preliminary analyses, used paired T-tests and chi-square tests to assess differences in physical, metabolic and dietary characteristics between yearly visits
- Performed partial correlations to assess relationship between changes in dietary variable (i.e., energy, macronutrients, total and added sugars, sugar, fructose, dietary fiber, insoluble fiber, soluble fiber, glycemic index (GI), glycemic load (GL) and food and beverage servings per day) and changes in glucose and insulin indexes (i.e., fasting and two-hour glucose and insulin, insulin sensitivity, acute insulin response, disposition indexes, glucose IAUC and insulin IAUC). These covariates were included in partial correlations:
    - Sex
    - Tanner stage

- Time between visits
- Baseline dietary variable and health outcome of interest
- Baseline and follow-up body composition (for insulin indexes)
- Subcutaneous abdominal adipose tissue (SAAT) [for VAT]

- Produced partial scatter plots of significant relation between changes in dietary variables and changes in adiposity or glucose and insulin indexes, adjusting for covariates listed above
- For significant partial correlations, did repeated-measures analysis of covariance.

Data Collection Summary:

Timing of Measurements

One to two years apart [mean (±SD) time difference of 1.5±0.5 years].

Dependent Variables

(Note: Refer to page 1,161 of article for measurements not described; details are very specific.)

- BMI percentile: [calculated from weight (to nearest 0.1kg) and height (to nearest 0.1cm) with beam medical scale and wall-mounted stadiometer by licensed pediatric health care provider
- BMI Z-score (calculated from weight/height above)
- Total fat (kg): Measured by DEXA with Hologic QDR 4500W
- Total lean (kg): Measured by DEXA with Hologic QDR 4500W
- Visceral abdominal tissue (VAT): Determined by magnetic resonance imaging done at university Imaging Science Center
- Subcutaneous abdominal adipose tissue (SAAT): Determined by magnetic resonance imaging done at university Imaging Science Center
- Fasting glucose (mg per dL)
- Two-hour glucose (mg per dL)
- Fasting insulin (µU per ml)
- Two-hour insulin (µU per ml)
- Glucose IAUC (nmol $\cdot min^{-1} \cdot L^{-1}$)
- Insulin IAUC (nmol $\cdot min^{-1} \cdot L^{-1}$)
- SI ($x10^{-4} \cdot min^{-1} \cdot \mu U^{-1} \cdot mL^{-1}$)
- AIR (µU/mL x 10 minutes)
- DI ($x10^{-4}$ per minute).

Independent Variables

(Note: See description of method of measurement under dietary intake section under design.)

- Nutrients
  - Energy (kcal)
  - Protein (percentage of kcal)
  - Fat (percentage of kcal)
  - CHO (percentage of kcal)
  - Total sugar (percentage of kcal)
  - Added sugar (percentage of kcal)
  - Dietary fiber (g per 1,000 kcal)
  - Insoluble fiber (g per 1,000 kcal)
  - Soluble fiber (g per 1,000 kcal)

    - Glycemic index
    - Glycemic load
- Food Groups
    - Meat (servings per day)
    - Dairy (servings per day)
    - Vegetables (servings per day, fried vegetables not included)
    - Fruit (servings per day, juice not included)
    - Whole grains (servings per day)
    - Refined grains (servings per day)
    - Sugar-sweetened beverages (servings per day).

Control Variables

- Sex
- Tanner stage (as measured by licensed pediatric health care provider)
- Time between visits
- Baseline dietary and metabolic variables of interest (seen above).

Description of Actual Data Sample:

- *Initial N:* 85 Latino youths meeting inclusion criteria who were already in the SOLAR study that started in 2000
- *Attrition (final N):* Not applicable because one of the inclusion criteria was that participants had already had two complete annual visits. Five potential participants were excluded when they did not meet inclusion criteria
- *Age:*
    - 48 males, 11 to 17 years
    - 37 females, 12 to 19 years
- *Ethnicity:* Latino (four Latino grandparents by self-report of parent)
- *Other relevant demographics:* 48.2% had one year between visits and 51.8% with two years between visits of dietary intake, adiposity measures and glucose and insulin indexes
- *Location:* University of Southern California, Los Angeles, CA.

Summary of Results:

Significant Nutrient Characteristics (N=85)	Baseline Measures	Follow-up Measures	P-value
Whole grains (servings per day)	0.9±1.2	1.2±1.6	0.04

Repeated-Measure ANCOVA Relating to Fiber Increasers vs. Fiber Decreasers and Change in VAT (*Models Adjusted for Sex, Tanner Stage, Time Between Visits, Baseline Visceral Adipose Tissue, Energy, Baseline Fiber Intake and Baseline Subcutaneous Abdominal Adipose Tissue)

Fiber increasers (N=39)	Mean decrease of 3g per 1,000kcal $^{-1}$ per day^{-1}	VAT (cm^{2}) increase of 21%	P-value

Fiber decreasers (N=46)	Mean increase of 3g per 1,000kcal $^{-1}$ per day^{-1}	VAT (cm^2) decrease of -4%	0.02

Changes in Total and Insoluble Fiber Intakes (g per 1,000kcal) Associations with VAT after Partial Correlations (*Adjusted for Sex, Tanner Stage, Baseline VAT, Total or Insoluble Fiber Intake and Baseline and Year Two Subcutaneous Abdominal Adipose Tissue)

Total Fiber	R=-0.29	P=0.02
Insoluble Fiber	R=- 0.27	P=0.03

Other Findings

- With use of paired T-tests and chi-square tests, a significant difference (P≤0.05) was observed in Tanner stage (P≤0.001), BMI percentile (P=0.002), BMI Z-score (P=0.003), total lean (P≤0.001), VAT (P=0.05), and fasting glucose (P=0.003) between the two visits
- Changes in CHO intake and soluble dietary fiber intake were not related to changes in any health outcome (P>0.20)
- Although partial correlation showed that insoluble fiber was inversely associated with VAT, the insoluble fiber category (increase compared with decrease) interaction for VAT was not significant (NS)
- Changes in energy intake, macronutrients, sugar variables and all food and beverage servings were not related to any changes in health outcomes
- Hypothesis was disproved (that decrease in sugar variables were related to improvements in insulin secretion); authors think mechanism might be that total and added sugar intakes were consistently high in both visits and there was no significant difference. Plus, subjects were older, at more advance pubertal stages and were already extremely insulin resistant and exhibiting early signs of ß cell dysfunction. Thus, the negative effect of sugar intake on ß cell function may have occurred earlier in this population and lack of any change over time masked the possibility of seeing any effects on metabolic outcomes
- Though dietary fiber intake was relatively low in this population (about 9g per 1,000kcal per day) and did NS change between visits, the changes did result in significant increase in visceral adiposity (discussed above and in conclusions). Mechanism may be related to less time in intestine, allowing for less time for digestion and absorption of nutrients that could directly affect total fat mass and finally visceral fat accumulation. Or, it may lower glycemic and insulinemic response to a meal and increase phytoestrogens that have inverse association with central adiposity.

Author Conclusion:

- Small reductions in dietary fiber intake over one to two years can have profound effects on increasing visceral adiposity in a high-risk Latino youth population
- Public health messages and interventions focusing on improving the quality of CHO intake, particularly increasing the intake of total and insoluble dietary fiber, for reducing obesity and related metabolic disorders are warranted in high-risk pediatric populations
- This study and results from another of our studies[19] suggest that modest increases in dietary fiber intake, the equivalent of one-half cup beans per day or one whole-wheat tortilla per day, could substantially lower visceral adiposity; this change was independent of energy intake with NS differences across years between those who increased and those who decreased caloric intake (64.2±798.6kcal per day compared to 86.8±728.1kcal per day,

P=0.09)
- Those who increased fiber consumed significantly more non-fried vegetables, more fruit and vegetables combined and more legumes between visits (increases of 1.3, two, and 0.5 servings per day respectively) compared with fiber decreasers.

Reviewer Comments:

- *Authors note following limitations:*
  - *Use of two 24-hour diet recalls, which rely on self-report, are often prone to errors. Attempted to rectify in study by using multi-pass method, using well-trained diet technicians, screening for and eliminating potential candidates with comments that would make them less reliable (i.e., sick at time of diet recall) and assessing plausibility of caloric intake by body weight*
  - *In this very homogeneous population of overweight Latino children with a family history of type 2 diabetes, it is possible that since they were already overweight, we would not see individual dietary factors affecting adiposity; however, we found an association between dietary fiber and visceral adiposity, independent of large variations in adiposity*
- *Reviewer comments:*
  - *As noted, diet recall method might not be most reliable; it is difficult enough to remember what one ate last night or last week, much less last year or two years ago, even with their modifications to method. Diet recall not only relied on two 24-hour diet recalls, they were of week days only, which could be different than weekend. The difference in type of food and portion to make a significant difference in visceral abdominal tissue was quite small and perhaps not as reliable if another diet recall method was used, or if it was done more frequently*
  - *Size of sample and specificity of study group make it hard to generalize to general high-risk pediatric population other than Latino youth.*

Research Design and Implementation Criteria Checklist: Primary Research

Relevance Questions

1.	Would implementing the studied intervention or procedure (if found successful) result in improved outcomes for the patients/clients/population group? (Not Applicable for some epidemiological studies)	Yes
2.	Did the authors study an outcome (dependent variable) or topic that the patients/clients/population group would care about?	Yes
3.	Is the focus of the intervention or procedure (independent variable) or topic of study a common issue of concern to nutrition or dietetics practice?	Yes
4.	Is the intervention or procedure feasible? (NA for some epidemiological studies)	Yes

Validity Questions

1.	**Was the research question clearly stated?**	Yes
1.1.	Was (were) the specific intervention(s) or procedure(s) [independent variable(s)] identified?	Yes
1.2.	Was (were) the outcome(s) [dependent variable(s)] clearly indicated?	Yes
1.3.	Were the target population and setting specified?	Yes
2.	**Was the selection of study subjects/patients free from bias?**	Yes
2.1.	Were inclusion/exclusion criteria specified (e.g., risk, point in disease progression, diagnostic or prognosis criteria), and with sufficient detail and without omitting criteria critical to the study?	Yes
2.2.	Were criteria applied equally to all study groups?	Yes
2.3.	Were health, demographics, and other characteristics of subjects described?	Yes
2.4.	Were the subjects/patients a representative sample of the relevant population?	No
3.	**Were study groups comparable?**	Yes
3.1.	Was the method of assigning subjects/patients to groups described and unbiased? (Method of randomization identified if RCT)	Yes
3.2.	Were distribution of disease status, prognostic factors, and other factors (e.g., demographics) similar across study groups at baseline?	Yes
3.3.	Were concurrent controls used? (Concurrent preferred over historical controls.)	Yes
3.4.	If cohort study or cross-sectional study, were groups comparable on important confounding factors and/or were preexisting differences accounted for by using appropriate adjustments in statistical analysis?	Yes
3.5.	If case control or cross-sectional study, were potential confounding factors comparable for cases and controls? (If case series or trial with subjects serving as own control, this criterion is not applicable. Criterion may not be applicable in some cross-sectional studies.)	Yes
3.6.	If diagnostic test, was there an independent blind comparison with an appropriate reference standard (e.g., "gold standard")?	N/A
4.	**Was method of handling withdrawals described?**	Yes
4.1.	Were follow-up methods described and the same for all groups?	Yes
4.2.	Was the number, characteristics of withdrawals (i.e., dropouts, lost to follow up, attrition rate) and/or response rate (cross-sectional studies) described for each group? (Follow up goal for a strong study is 80%.)	N/A

4.3.	Were all enrolled subjects/patients (in the original sample) accounted for?	Yes
4.4.	Were reasons for withdrawals similar across groups?	N/A
4.5.	If diagnostic test, was decision to perform reference test not dependent on results of test under study?	N/A
5.	**Was blinding used to prevent introduction of bias?**	Yes
5.1.	In intervention study, were subjects, clinicians/practitioners, and investigators blinded to treatment group, as appropriate?	N/A
5.2.	Were data collectors blinded for outcomes assessment? (If outcome is measured using an objective test, such as a lab value, this criterion is assumed to be met.)	Yes
5.3.	In cohort study or cross-sectional study, were measurements of outcomes and risk factors blinded?	Yes
5.4.	In case control study, was case definition explicit and case ascertainment not influenced by exposure status?	N/A
5.5.	In diagnostic study, were test results blinded to patient history and other test results?	N/A
6.	**Were intervention/therapeutic regimens/exposure factor or procedure and any comparison(s) described in detail? Were interveningfactors described?**	Yes
6.1.	In RCT or other intervention trial, were protocols described for all regimens studied?	N/A
6.2.	In observational study, were interventions, study settings, and clinicians/provider described?	Yes
6.3.	Was the intensity and duration of the intervention or exposure factor sufficient to produce a meaningful effect?	Yes
6.4.	Was the amount of exposure and, if relevant, subject/patient compliance measured?	Yes
6.5.	Were co-interventions (e.g., ancillary treatments, other therapies) described?	N/A
6.6.	Were extra or unplanned treatments described?	N/A
6.7.	Was the information for 6.4, 6.5, and 6.6 assessed the same way for all groups?	N/A
6.8.	In diagnostic study, were details of test administration and replication sufficient?	N/A
7.	**Were outcomes clearly defined and the measurements valid and reliable?**	Yes
7.1.	Were primary and secondary endpoints described and relevant to the question?	Yes
7.2.	Were nutrition measures appropriate to question and outcomes of concern?	Yes

7.3.	Was the period of follow-up long enough for important outcome(s) to occur?	Yes
7.4.	Were the observations and measurements based on standard, valid, and reliable data collection instruments/tests/procedures?	Yes
7.5.	Was the measurement of effect at an appropriate level of precision?	No
7.6.	Were other factors accounted for (measured) that could affect outcomes?	Yes
7.7.	Were the measurements conducted consistently across groups?	Yes
8.	**Was the statistical analysis appropriate for the study design and type of outcome indicators?**	Yes
8.1.	Were statistical analyses adequately described and the results reported appropriately?	Yes
8.2.	Were correct statistical tests used and assumptions of test not violated?	Yes
8.3.	Were statistics reported with levels of significance and/or confidence intervals?	Yes
8.4.	Was "intent to treat" analysis of outcomes done (and as appropriate, was there an analysis of outcomes for those maximally exposed or a dose-response analysis)?	N/A
8.5.	Were adequate adjustments made for effects of confounding factors that might have affected the outcomes (e.g., multivariate analyses)?	Yes
8.6.	Was clinical significance as well as statistical significance reported?	Yes
8.7.	If negative findings, was a power calculation reported to address type 2 error?	No
9.	**Are conclusions supported by results with biases and limitations taken into consideration?**	Yes
9.1.	Is there a discussion of findings?	Yes
9.2.	Are biases and study limitations identified and discussed?	Yes
10.	**Is bias due to study's funding or sponsorship unlikely?**	Yes
10.1.	Were sources of funding and investigators' affiliations described?	Yes
10.2.	Was the study free from apparent conflict of interest?	Yes